Lecture 11
ECE4884A (ECE4007)
ECE Culminating Design Project

Preliminary Design Review
Project Documentation

2008 February 20

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Preliminary Design Review (PDR)

Upcoming during two weeks of March 3-14

Details specific to your Project Advisor and section

Graded jointly by your Project Advisor and UPCP

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Preliminary Design Review (PDR)

Common Industrial Practice

- Primary purpose is a thorough technical review
  - Convince whomever is funding your project that:
    - The design is sound
    - You are making reasonable progress
    - A favorable outcome is likely
  - Review specifications, particularly any changes
  - Give an in-depth review of the design approach and details
  - Review plan for demonstration and acceptance testing
- Other purposes:
  - Review project tasks and schedule
  - Present marketing and cost analysis if appropriate
- The PDR convinces your funding source to keep on supporting you
- An unsuccessful PDR outcome is project cancellation
- Should be optimistic but realistic
- Don't cover up problems!

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PDR Presentation Guidelines

- Presentation must be in PowerPoint (not a PDF)
- Every team member must give a non-trivial part of the presentation (several minutes)
- Your audience for the presentation is company management (including technical management) and engineering peers who will be evaluating your progress
- You need to convince management that your project is worthy of continued support and that any problems are understood and under control
- Your presentation should include graphical information such as block diagrams, screen layouts, flow charts, etc. and not just text
- Should clearly indicate current project status

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Project Documentation for the PDR

- A PDR presentation cannot properly show all needed project documentation
- A supplementary documentation package may be required (check with your project advisor)
- Should convey technical details beyond the scope of a presentation such as:
  - Detailed schematics
  - Mechanical drawings
  - Screen layouts (GUI details)
  - Detailed block diagrams and flow charts
- Prepare a hardcopy package for your project advisor and post all information to your project website (as a zip file)

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Project Documentation

A critical aspect of your final project deliverables (& supporting your PDR for some Project Advisors).

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Types of Project Documentation

- System (High) Level
  - "Big picture" block diagrams
- Detail (Low) Level
  - Electrical schematics, mechanical drawings
- Interconnections
  - How different modules are connected
- Software
  - Flow charts, commented source code
- End User (Customer) Documentation
  - Operator's manual, maintenance manual, etc.
- General Project
  - Document the design process

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High Level Block Diagrams

Needed for every report and presentation

- Show functional elements – these are not necessarily physical elements, although they often are
- Clearly label each element
- Indicate interconnections and connectivity type (e.g. analog, digital, data bus, etc.)
- Label all interconnections
- Use arrows to show directionality

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Previous Example – System Description

- PC-Based Oscilloscope (TDS5034)
  - Controls multiplexer via USB interface
  - Controls pulser-receiver via GPIB interface
  - Runs LabView
- Pulser Receiver
  - Signal output goes to scope input and is digitized
  - Transmit and Receiver are connected to the Mux
- Eight Channel Multiplexer
  - Supports up to 8 transducers
  - Routes Transmit and Receive to/from transducers
  - USB interface with scope PC

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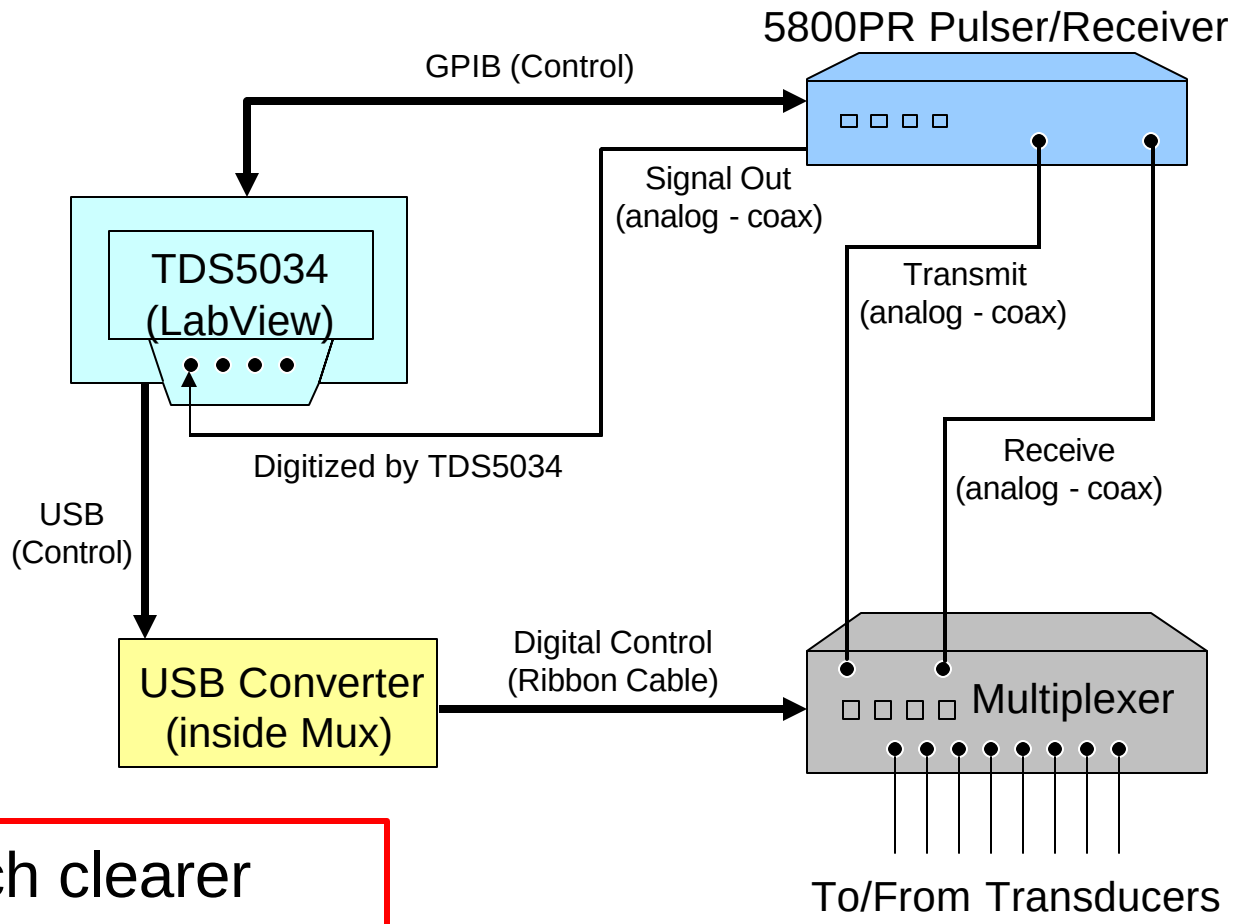
Previous Example – System Block Diagram



- Much clearer
- More information

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Would you rather:

Look at a Block Diagram
or
Read a Text Description?

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Example – System Description
Ultrasonic Structural Health Monitoring System

- Sensor Cluster
  - Multiple ultrasonic sensors (up to 16 per cluster)
  - Each sensor can operate as a transmitter or a receiver
  - Synchronization between all sensors in a cluster
  - Processing capabilities for local data analysis
- Structure with Multiple Sensor Clusters
  - Local sensors for monitoring small areas
  - Global sensors for monitoring large areas
- Wireless Link
  - Sends raw waveforms or processed data to base station
  - COTS USB link (2.4 GHz)
- Base Station
  - Further processing of data
  - Can link/combine data from multiple sensor clusters

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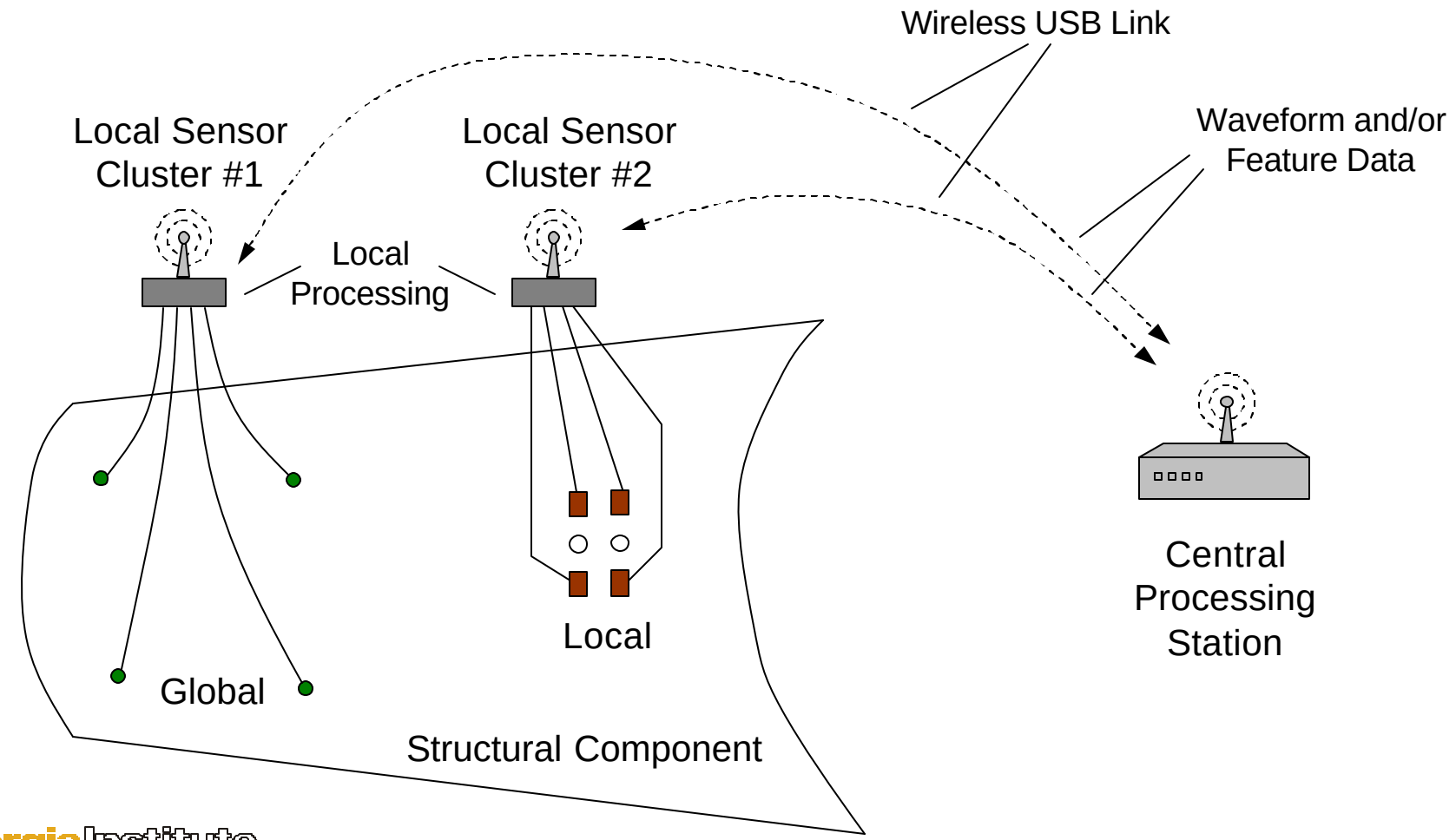
Example – System Description

Ultrasonic Structural Health Monitoring System



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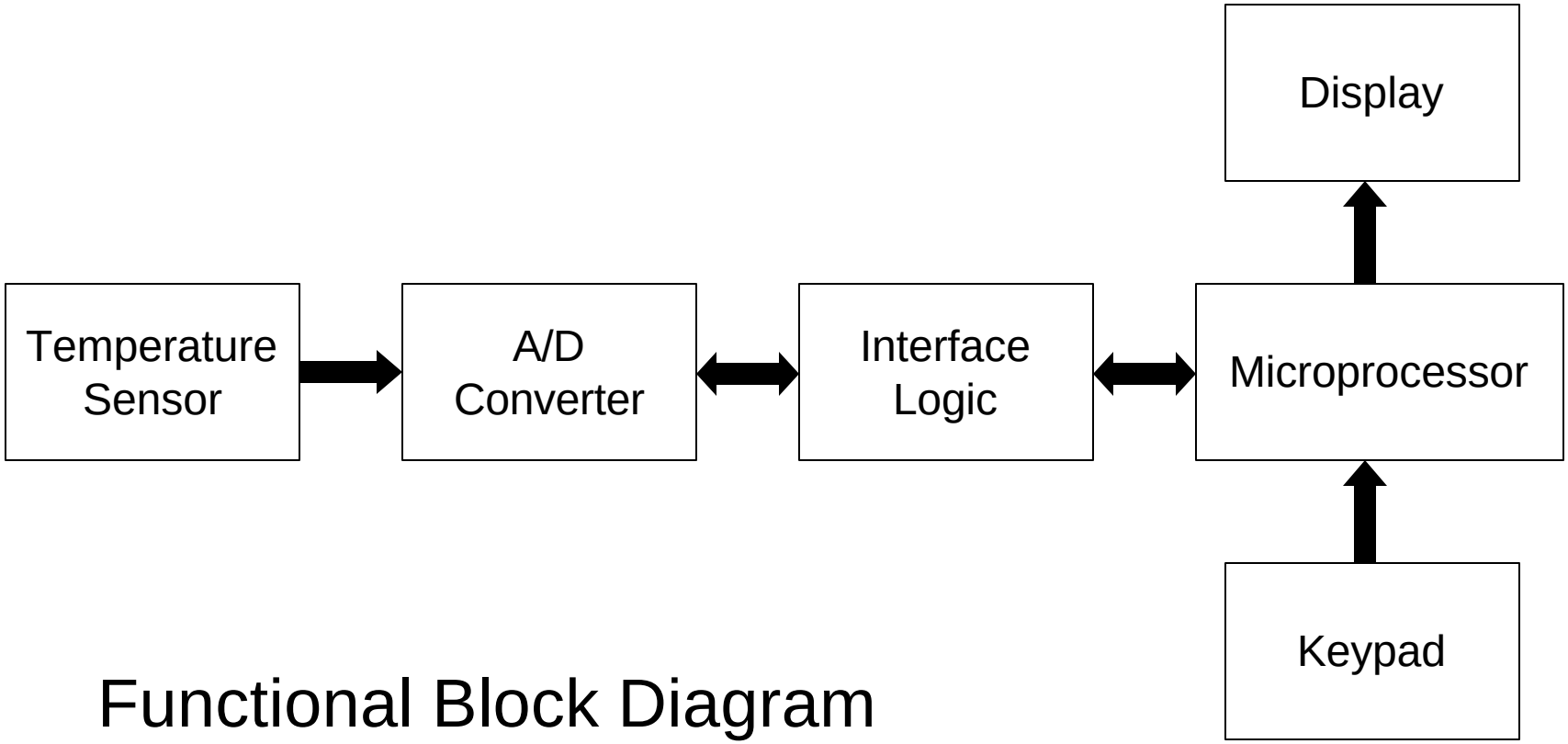
Temperature Monitor



Functional Block Diagram

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Electronic Files

- Mechanical drawings
- Electrical/electronic schematics
- Software source code
- Project planning charts

Use a version/revision scheme for naming files, and on all title blocks and software headers. Date and keep a chronological record of revisions.

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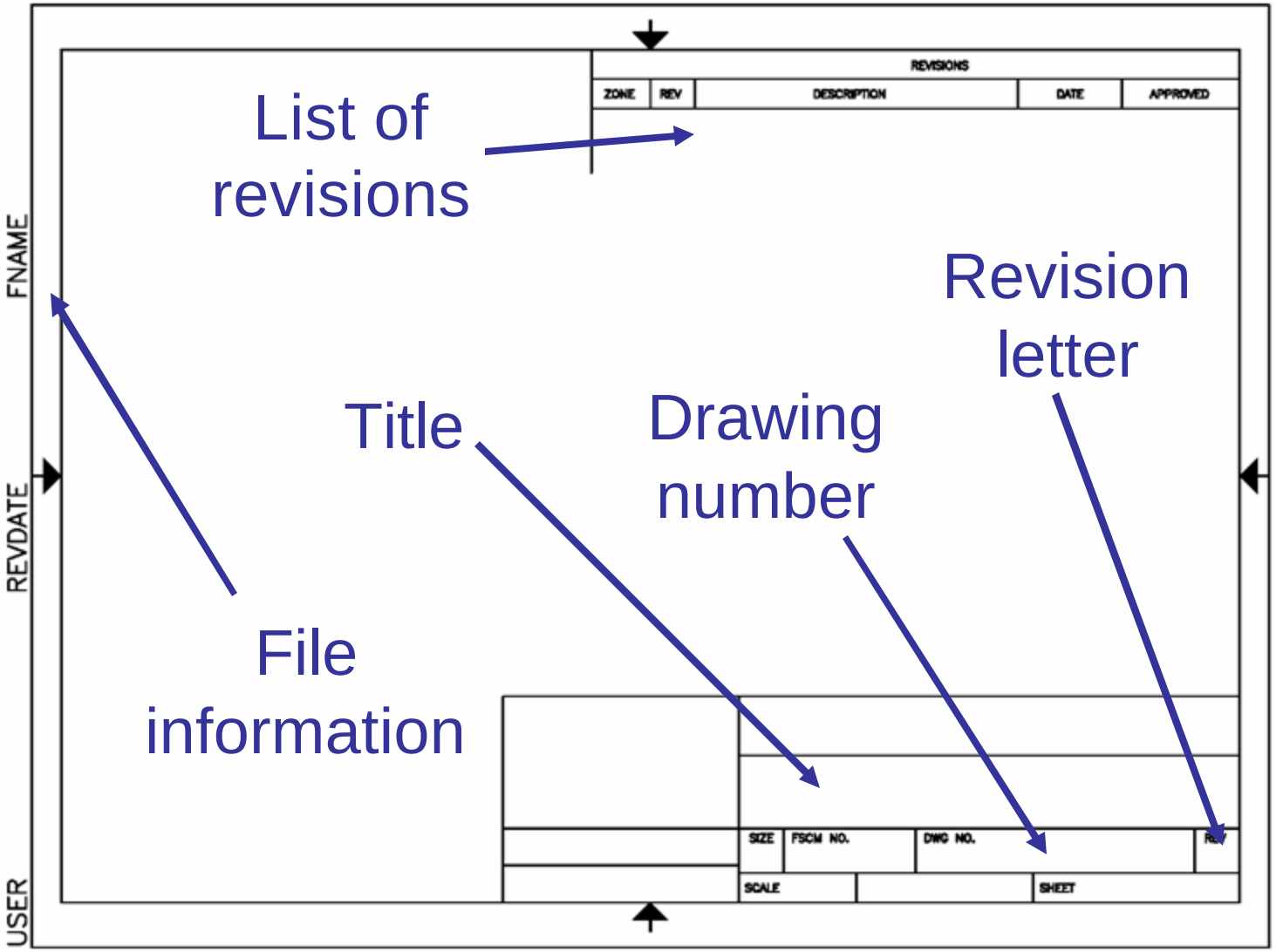
Typical ANSI Standard Title Block

ANSI = American National Standards Institute



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Electrical/Electronic Schematics

- Physical layout:
  - Show components, I/O connectors, and interconnections between circuit blocks
- Parts list:
  - List all procured parts and vendors
  - Numbers assigned must agree with physical layout and schematics
- Schematics:
  - Label components with part numbers, values, and identifier numbers (e.g. U1, U2, R1, R2, …)
  - Label all I/O connectors and interconnections between schematics
  - Try to make signals “flow” from left-to-right and top-to-bottom (inputs on left/top, outputs on right/bottom)

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Schematic Example

VHF Pre-Amplifier: Ramsey PR-20

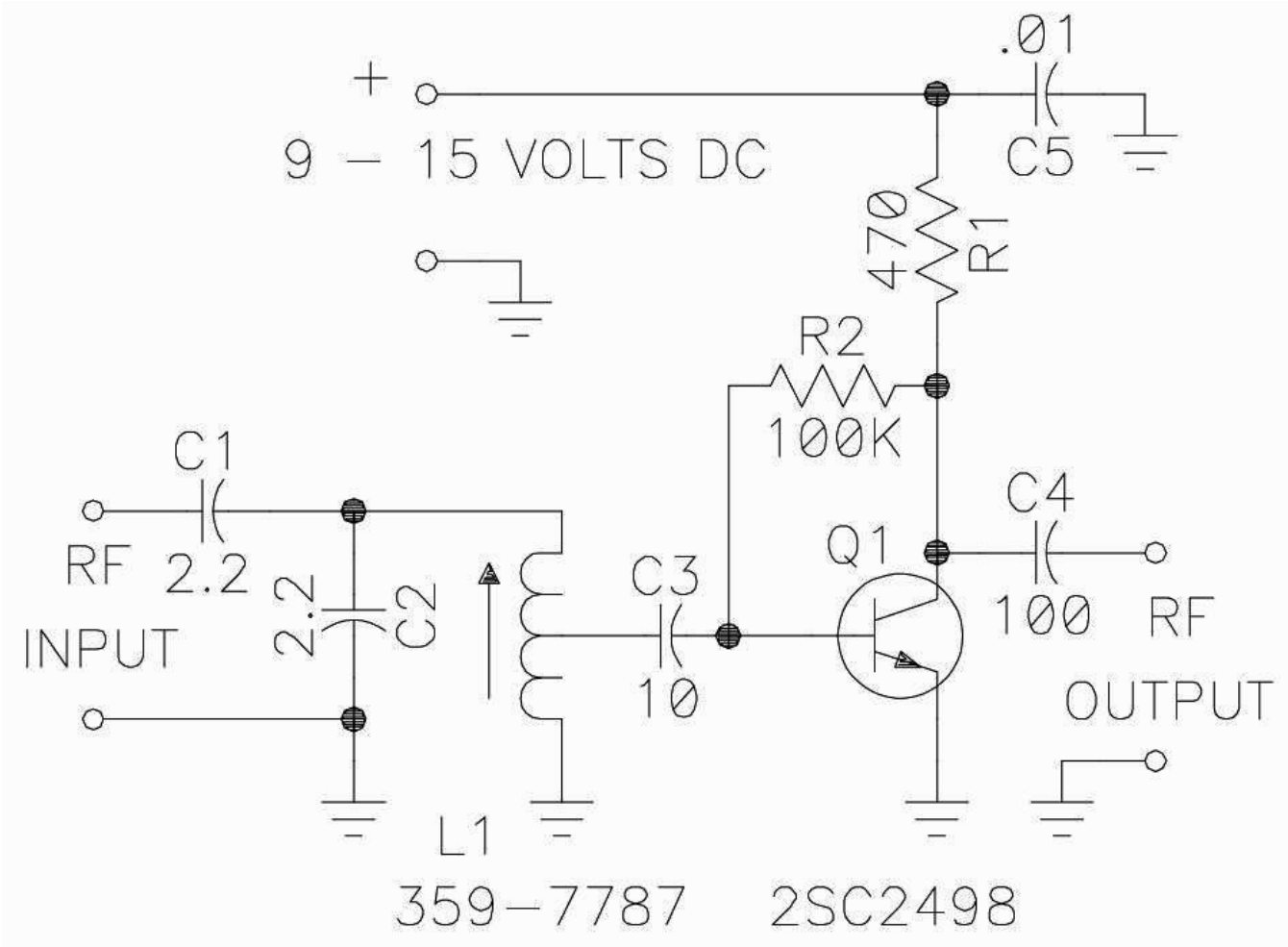
Units:

- Capacitors
- Resistors

Signal Flow

Power Flow

Inductor Arrow



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Complex Schematic Example

- Servo controller board
  - Multi-page schematic
  - Component overlay
  - Silkscreen overlay

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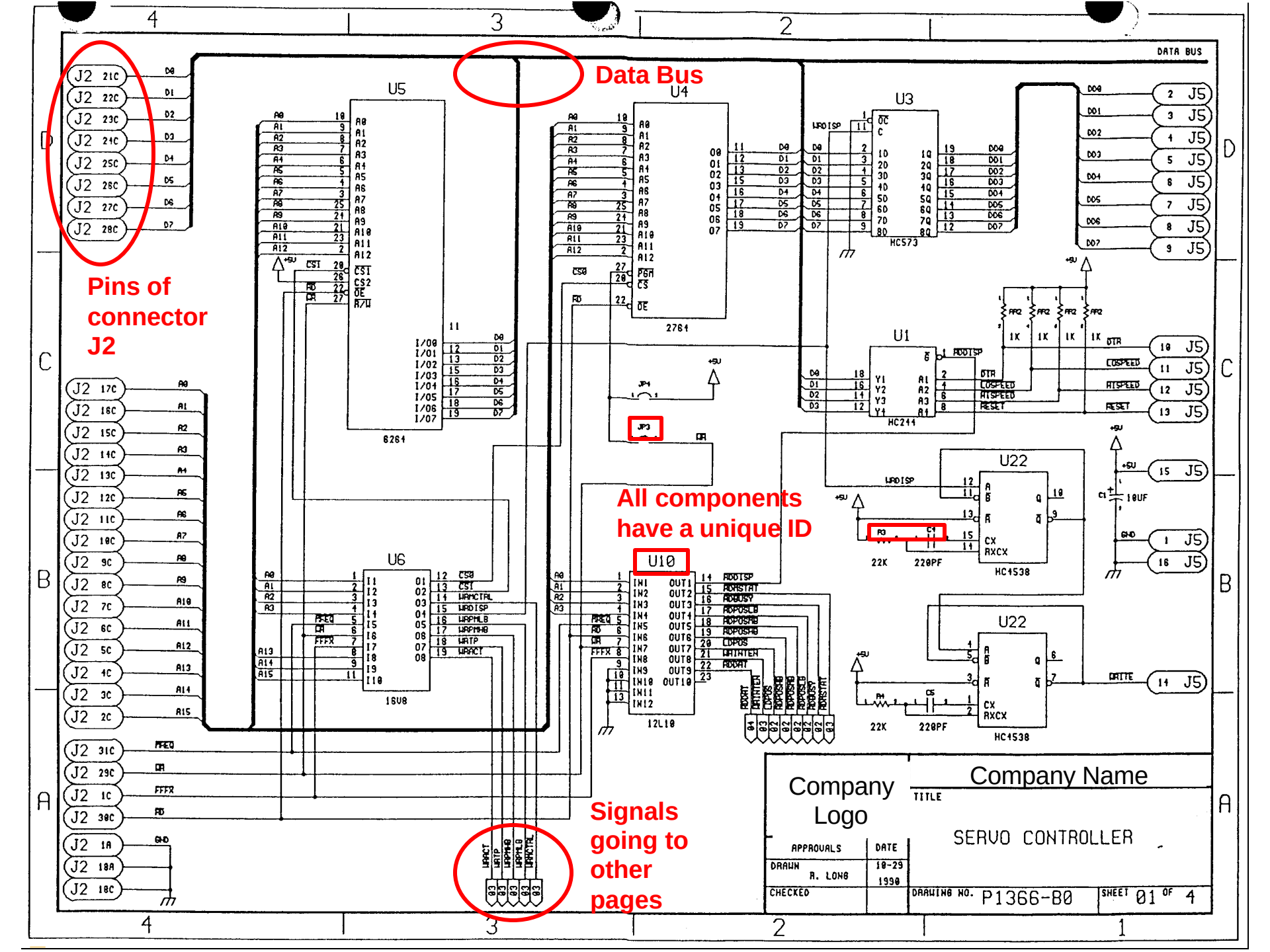
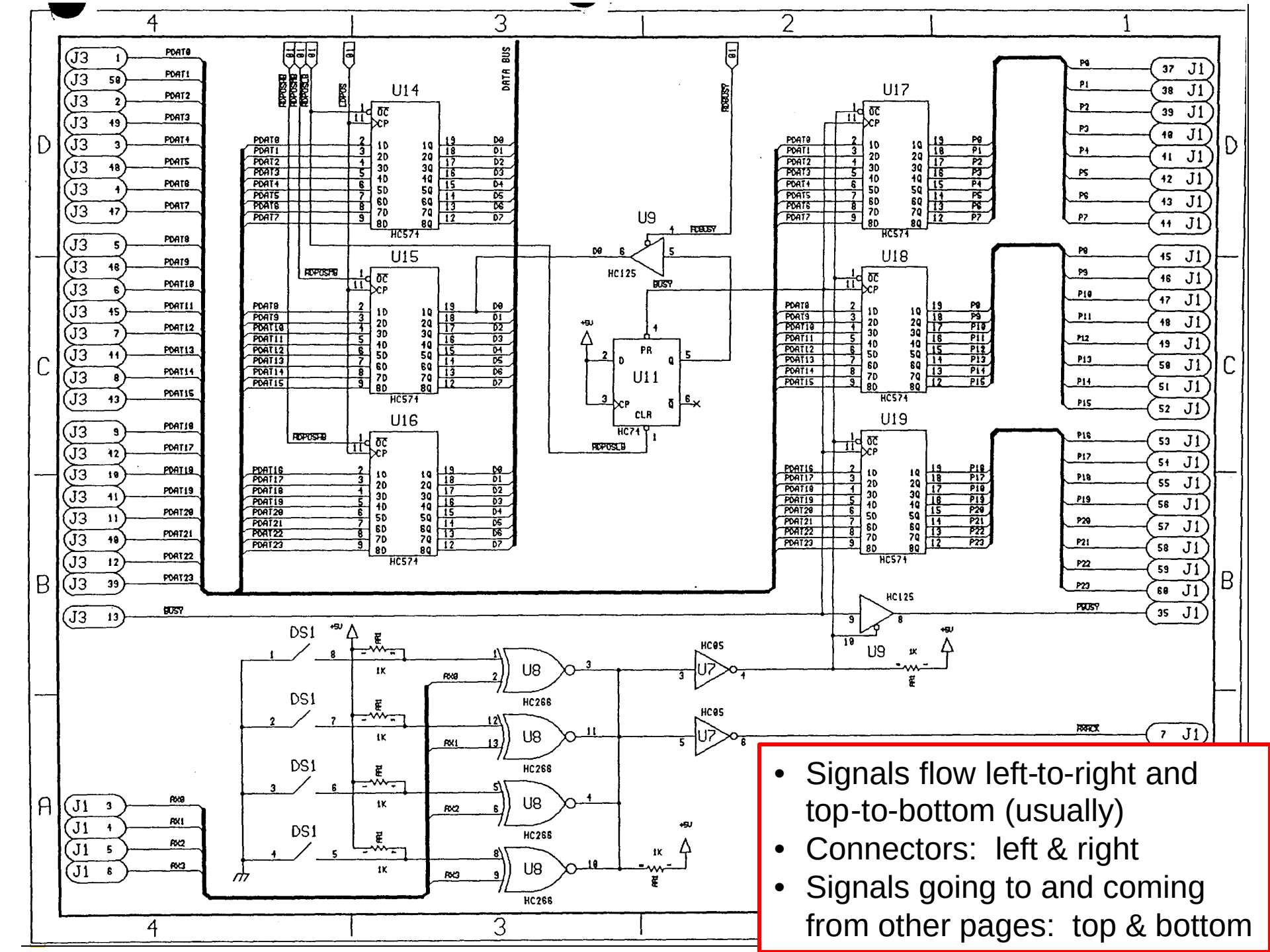
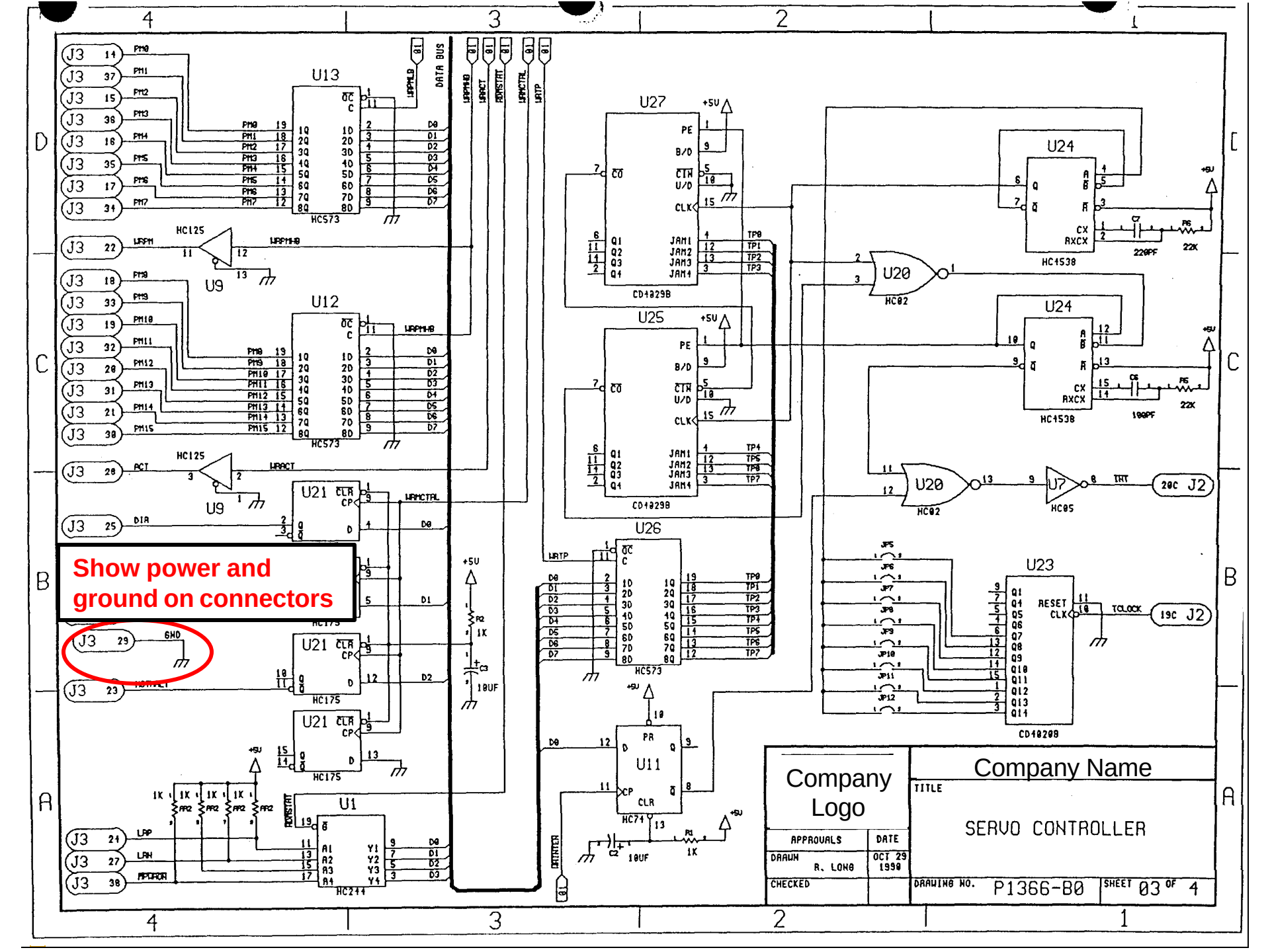
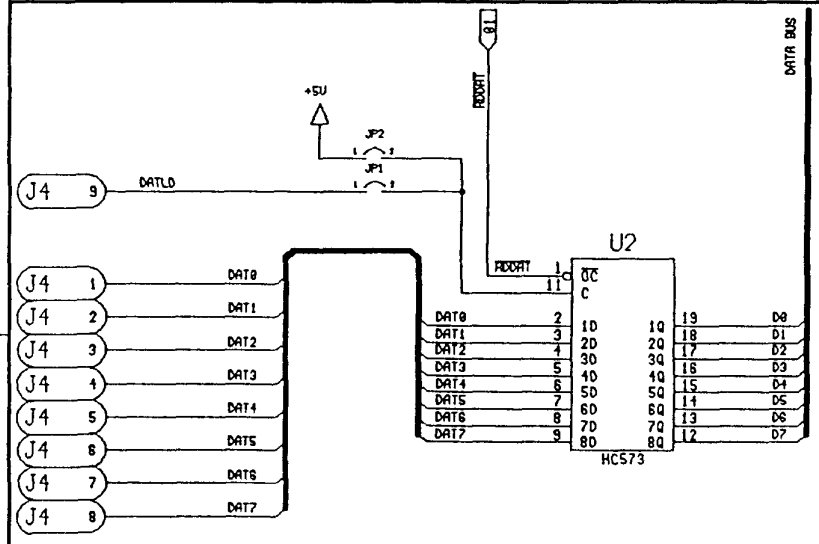
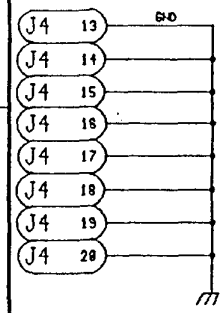

Data Bus
Pins of connector J2
All components have a unique ID
Signals going to other pages
DATA BUS
U5
U4
U3
U1
U22
U6
U10
6264
2764
HC573
HC244
HC4538
16V8
12L10
Company Logo
Company Name
TITLE
SERVO CONTROLLER
APPROVALS
DATE
DRAWN
R. LONG
10-29
1990
CHECKED
DRAWING NO. P1366-B0
SHEET 01 OF 4

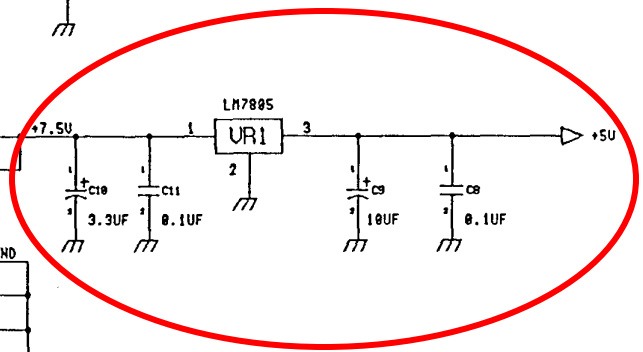


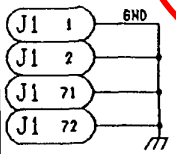
- Signals flow left-to-right and top-to-bottom (usually)
- Connectors: left & right
- Signals going to and coming from other pages: top & bottom


Show power and ground on connectors
U13
U12
U21
U1
U27
U25
U26
U24
U20
U23
U11
U9
U7
HC573
HC175
HC244
HC74
HC02
HC05
HC4538
CD40208
CD4029B
HC125
DATA BUS
+5U
GND
Company Logo
Company Name
TITLE
SERVO CONTROLLER
APPROVALS
DATE
DRAWN
R. LONG
OCT 29 1999
CHECKED
DRAWING NO.
P1366-B0
SHEET 03 OF 4

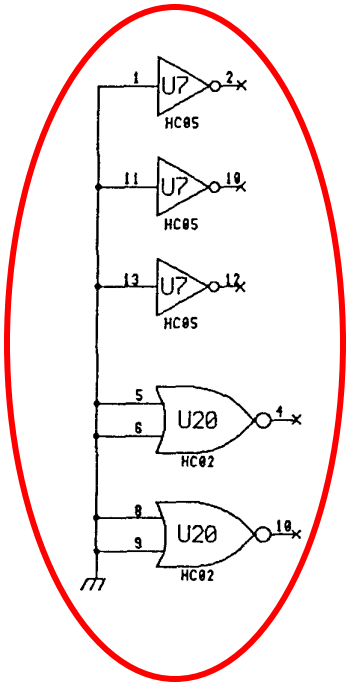






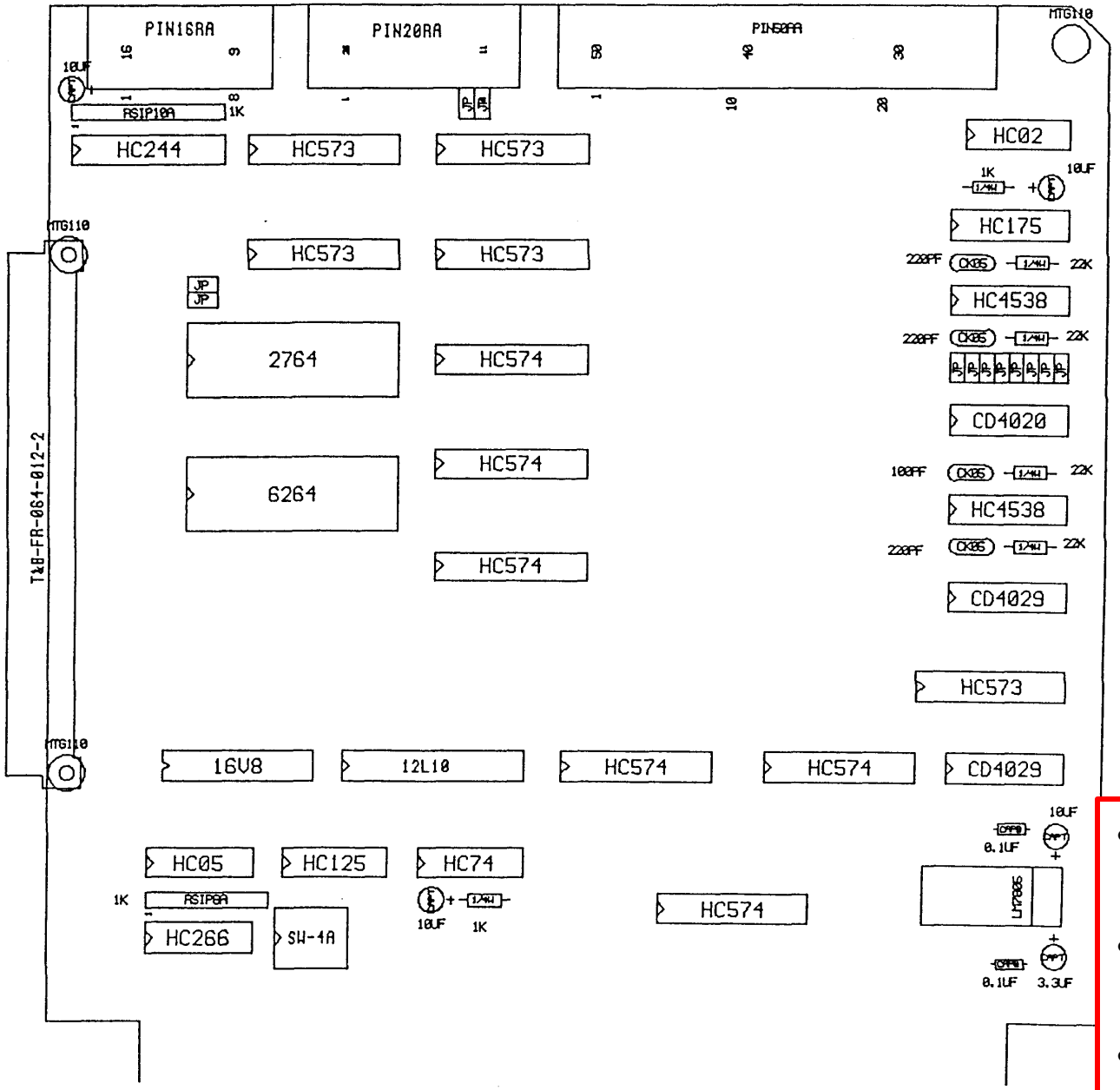


Voltage regulator and decoupling caps



Unused Gates

Company Logo	Company Name
	TITLE: SERVO CONTROLLER
APPROVALS / DATE	
DRAWN R. LONG / OCT 29 1990	
CHECKED	
	DRAWING NO. P1366-B0 — SHEET 04 OF 4



- **Physical locations shown for all parts**
- **All part numbers identified**
- **All component values identified**

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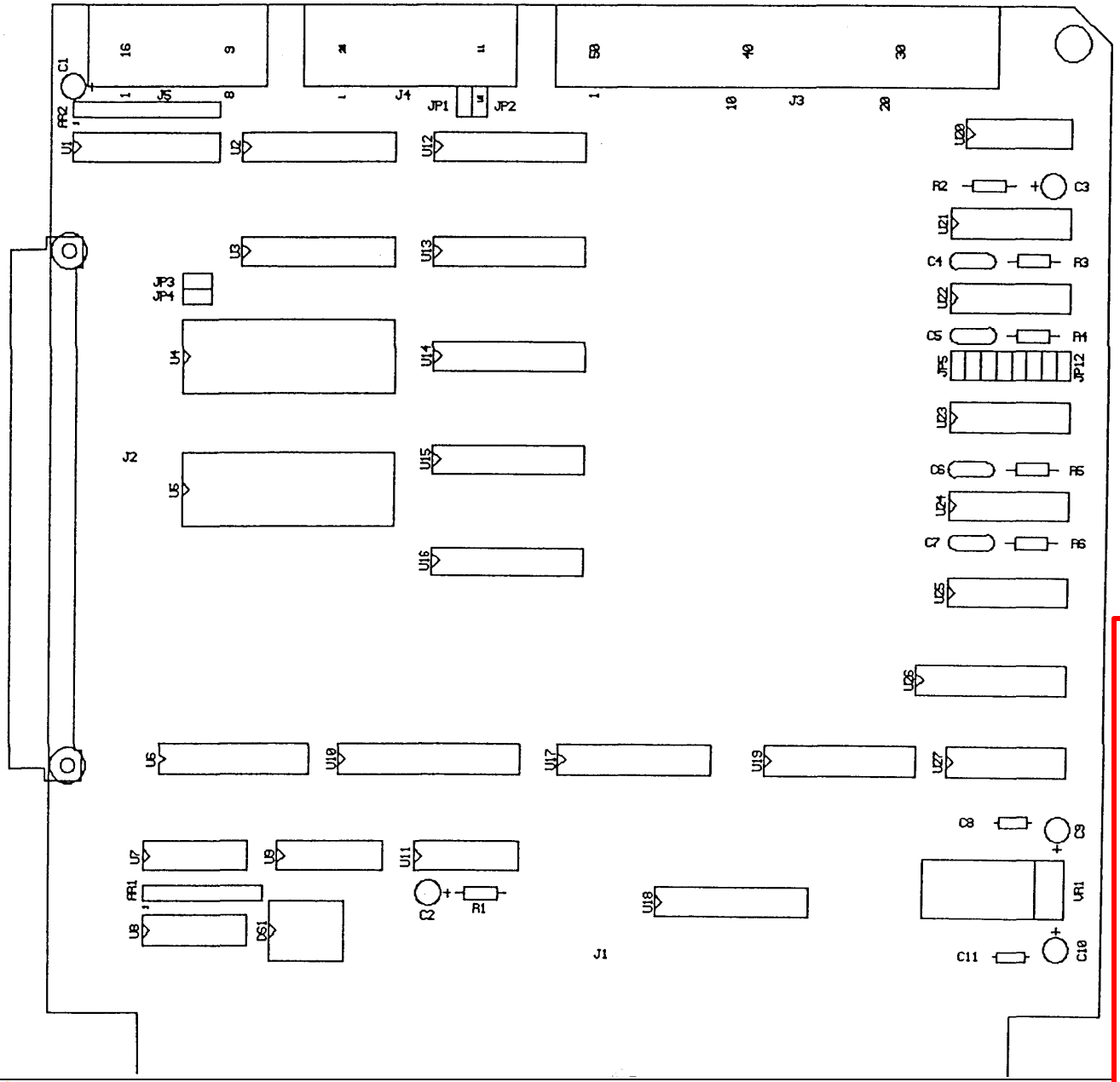

- **Physical locations related to unique component identifiers**
- **Part numbers and component values are often on this drawing (better than separate drawings)**

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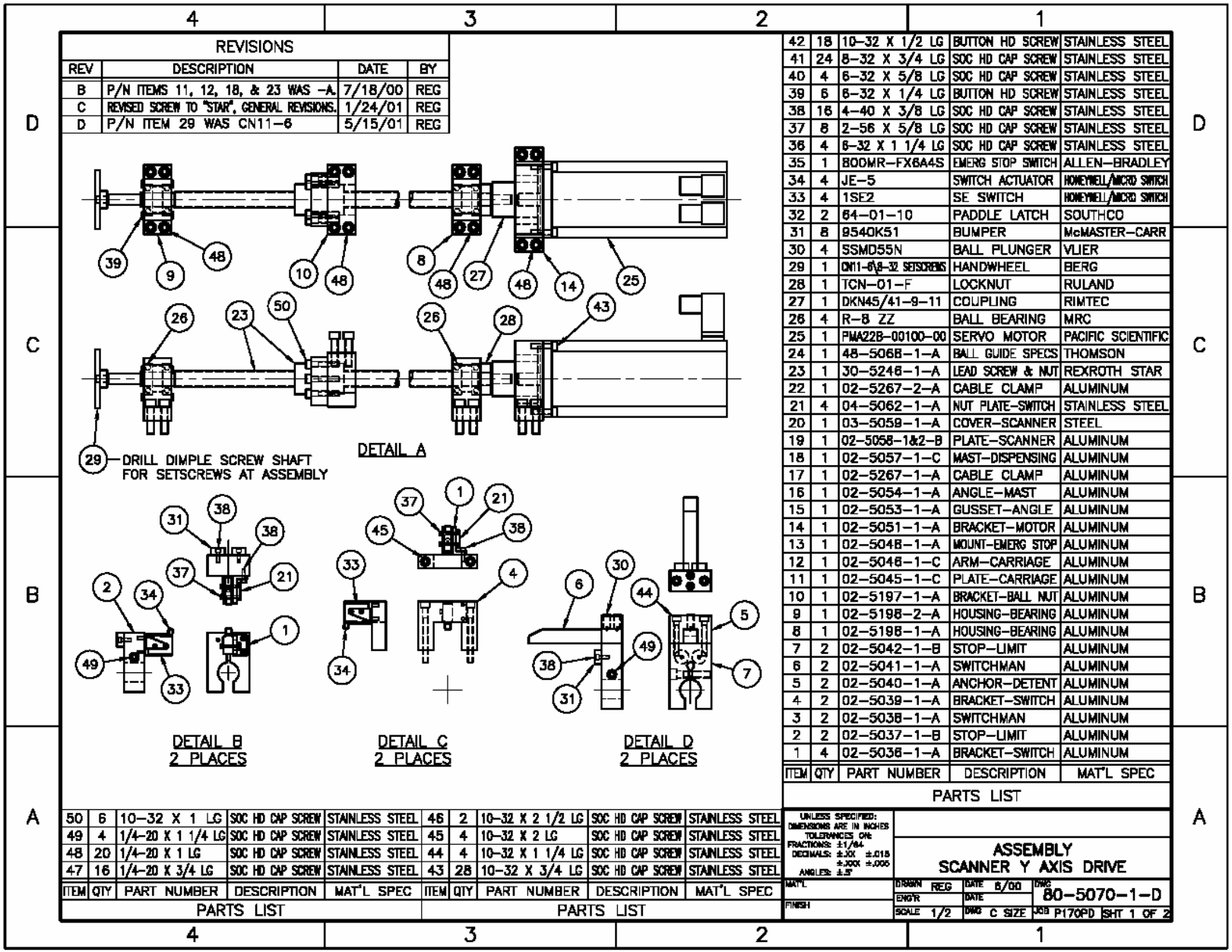
REVISIONS
REV | DESCRIPTION | DATE | BY
B | P/N ITEMS 11, 12, 18, & 23 WAS -A. | 7/18/00 | REG
C | REVISED SCREW TO "STAR", GENERAL REVISIONS. | 1/24/01 | REG
D | P/N ITEM 29 WAS CN11-6 | 5/15/01 | REG
DETAIL A
29 DRILL DIMPLE SCREW SHAFT FOR SETSCREWS AT ASSEMBLY
DETAIL B 2 PLACES
DETAIL C 2 PLACES
DETAIL D 2 PLACES
PARTS LIST
ITEM | QTY | PART NUMBER | DESCRIPTION | MAT'L SPEC
42 | 18 | 10-32 X 1/2 LG | BUTTON HD SCREW | STAINLESS STEEL
41 | 24 | 8-32 X 3/4 LG | SOC HD CAP SCREW | STAINLESS STEEL
40 | 4 | 6-32 X 5/8 LG | SOC HD CAP SCREW | STAINLESS STEEL
39 | 6 | 6-32 X 1/4 LG | BUTTON HD SCREW | STAINLESS STEEL
38 | 16 | 4-40 X 3/8 LG | SOC HD CAP SCREW | STAINLESS STEEL
37 | 8 | 2-56 X 5/8 LG | SOC HD CAP SCREW | STAINLESS STEEL
36 | 4 | 6-32 X 1 1/4 LG | SOC HD CAP SCREW | STAINLESS STEEL
35 | 1 | 800MR-FX6A4S | EMERG STOP SWITCH | ALLEN-BRADLEY
34 | 4 | JE-5 | SWITCH ACTUATOR | HONEYWELL/MICRO SWITCH
33 | 4 | 1SE2 | SE SWITCH | HONEYWELL/MICRO SWITCH
32 | 2 | 64-01-10 | PADDLE LATCH | SOUTHCO
31 | 8 | 9540K51 | BUMPER | McMASTER-CARR
30 | 4 | SSMD55N | BALL PLUNGER | VLIER
29 | 1 | CN11-6\8-32 SETSCREWS | HANDWHEEL | BERG
28 | 1 | TCN-01-F | LOCKNUT | RULAND
27 | 1 | DKN45/41-9-11 | COUPLING | RIMTEC
26 | 4 | R-8 ZZ | BALL BEARING | MRC
25 | 1 | PMA22B-00100-00 | SERVO MOTOR | PACIFIC SCIENTIFIC
24 | 1 | 48-5068-1-A | BALL GUIDE SPECS | THOMSON
23 | 1 | 30-5246-1-A | LEAD SCREW & NUT | REXROTH STAR
22 | 1 | 02-5267-2-A | CABLE CLAMP | ALUMINUM
21 | 4 | 04-5062-1-A | NUT PLATE-SWITCH | STAINLESS STEEL
20 | 1 | 03-5059-1-A | COVER-SCANNER | STEEL
19 | 1 | 02-5058-1&2-B | PLATE-SCANNER | ALUMINUM
18 | 1 | 02-5057-1-C | MAST-DISPENSING | ALUMINUM
17 | 1 | 02-5267-1-A | CABLE CLAMP | ALUMINUM
16 | 1 | 02-5054-1-A | ANGLE-MAST | ALUMINUM
15 | 1 | 02-5053-1-A | GUSSET-ANGLE | ALUMINUM
14 | 1 | 02-5051-1-A | BRACKET-MOTOR | ALUMINUM
13 | 1 | 02-5048-1-A | MOUNT-EMERG STOP | ALUMINUM
12 | 1 | 02-5046-1-C | ARM-CARRIAGE | ALUMINUM
11 | 1 | 02-5045-1-C | PLATE-CARRIAGE | ALUMINUM
10 | 1 | 02-5197-1-A | BRACKET-BALL NUT | ALUMINUM
9 | 1 | 02-5198-2-A | HOUSING-BEARING | ALUMINUM
8 | 1 | 02-5198-1-A | HOUSING-BEARING | ALUMINUM
7 | 2 | 02-5042-1-B | STOP-LIMIT | ALUMINUM
6 | 2 | 02-5041-1-A | SWITCHMAN | ALUMINUM
5 | 2 | 02-5040-1-A | ANCHOR-DETENT | ALUMINUM
4 | 2 | 02-5039-1-A | BRACKET-SWITCH | ALUMINUM
3 | 2 | 02-5038-1-A | SWITCHMAN | ALUMINUM
2 | 2 | 02-5037-1-B | STOP-LIMIT | ALUMINUM
1 | 4 | 02-5036-1-A | BRACKET-SWITCH | ALUMINUM
PARTS LIST
50 | 6 | 10-32 X 1 LG | SOC HD CAP SCREW | STAINLESS STEEL
49 | 4 | 1/4-20 X 1 1/4 LG | SOC HD CAP SCREW | STAINLESS STEEL
48 | 20 | 1/4-20 X 1 LG | SOC HD CAP SCREW | STAINLESS STEEL
47 | 16 | 1/4-20 X 3/4 LG | SOC HD CAP SCREW | STAINLESS STEEL
46 | 2 | 10-32 X 2 1/2 LG | SOC HD CAP SCREW | STAINLESS STEEL
45 | 4 | 10-32 X 2 LG | SOC HD CAP SCREW | STAINLESS STEEL
44 | 4 | 10-32 X 1 1/4 LG | SOC HD CAP SCREW | STAINLESS STEEL
43 | 28 | 10-32 X 3/4 LG | SOC HD CAP SCREW | STAINLESS STEEL
PARTS LIST
UNLESS SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES ON: FRACTIONS: ±1/64 DECIMALS: ±.XX ±.015 ±.XXX ±.005 ANGLES: ±.5°
MAT'L
FINISH
ASSEMBLY
SCANNER Y AXIS DRIVE
DRAWN REG DATE 6/00
ENG'R DATE
SCALE 1/2 DWG C SIZE JOB P170PD SHT 1 OF 2
DWG 80-5070-1-D

Mechanical Assembly Drawing

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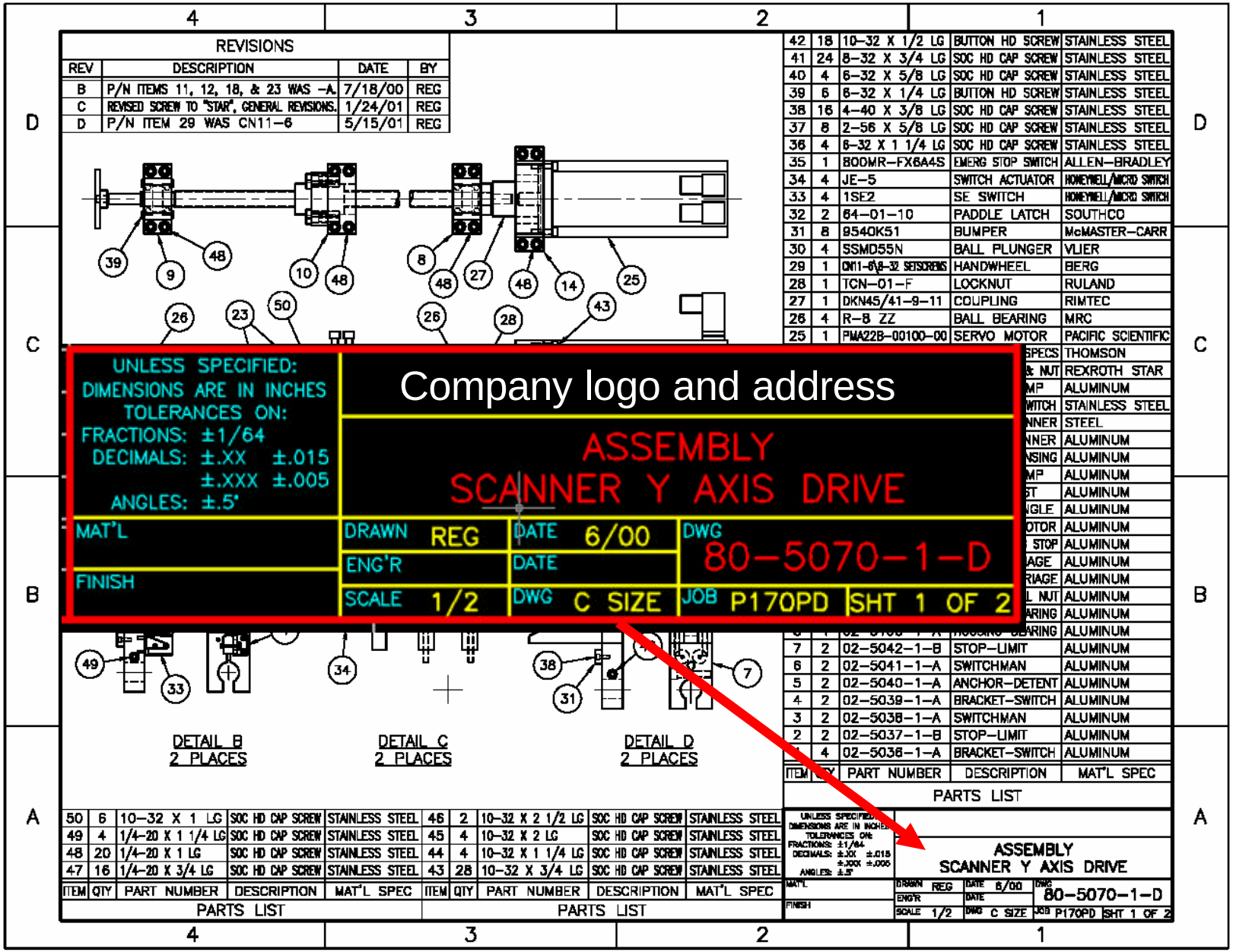
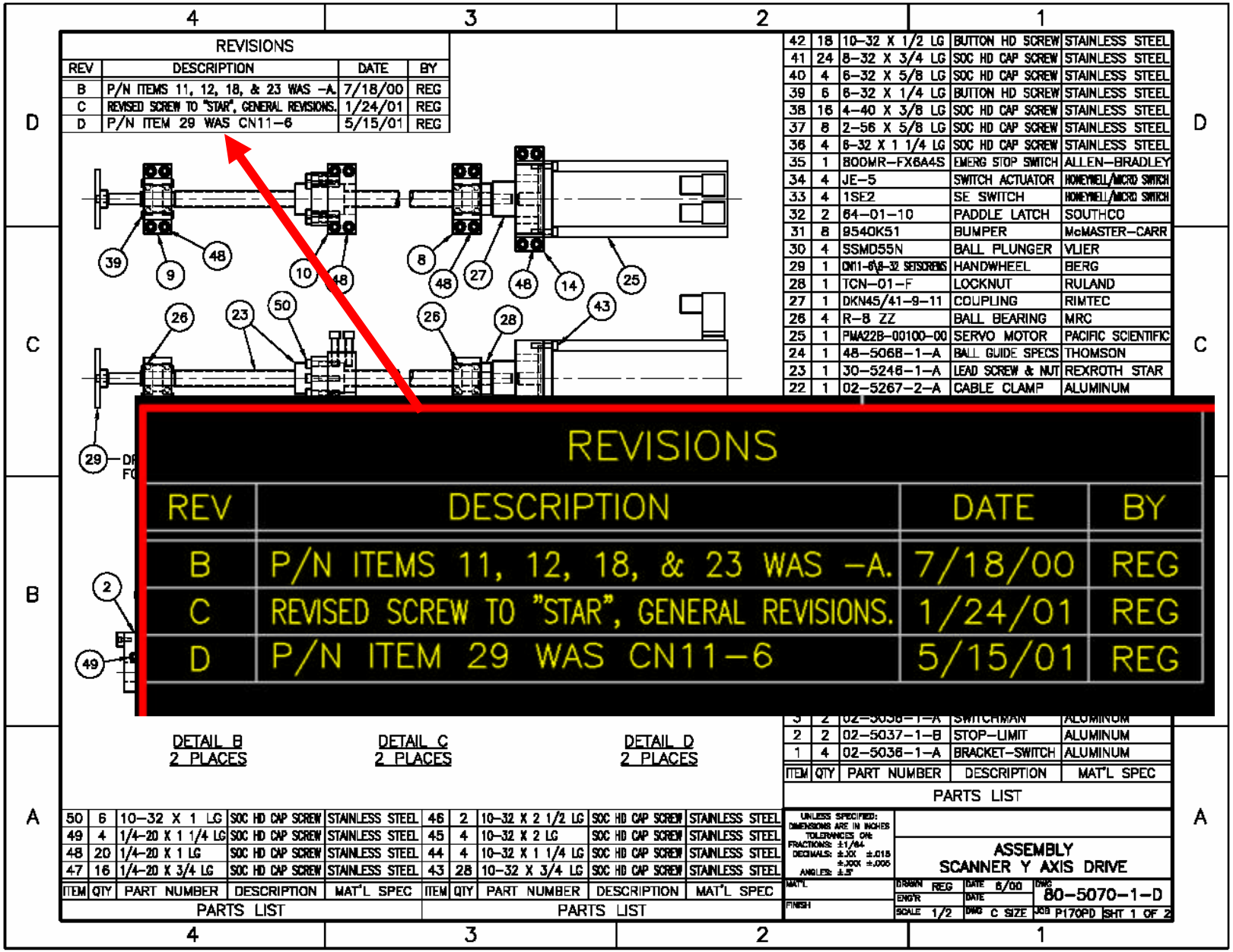
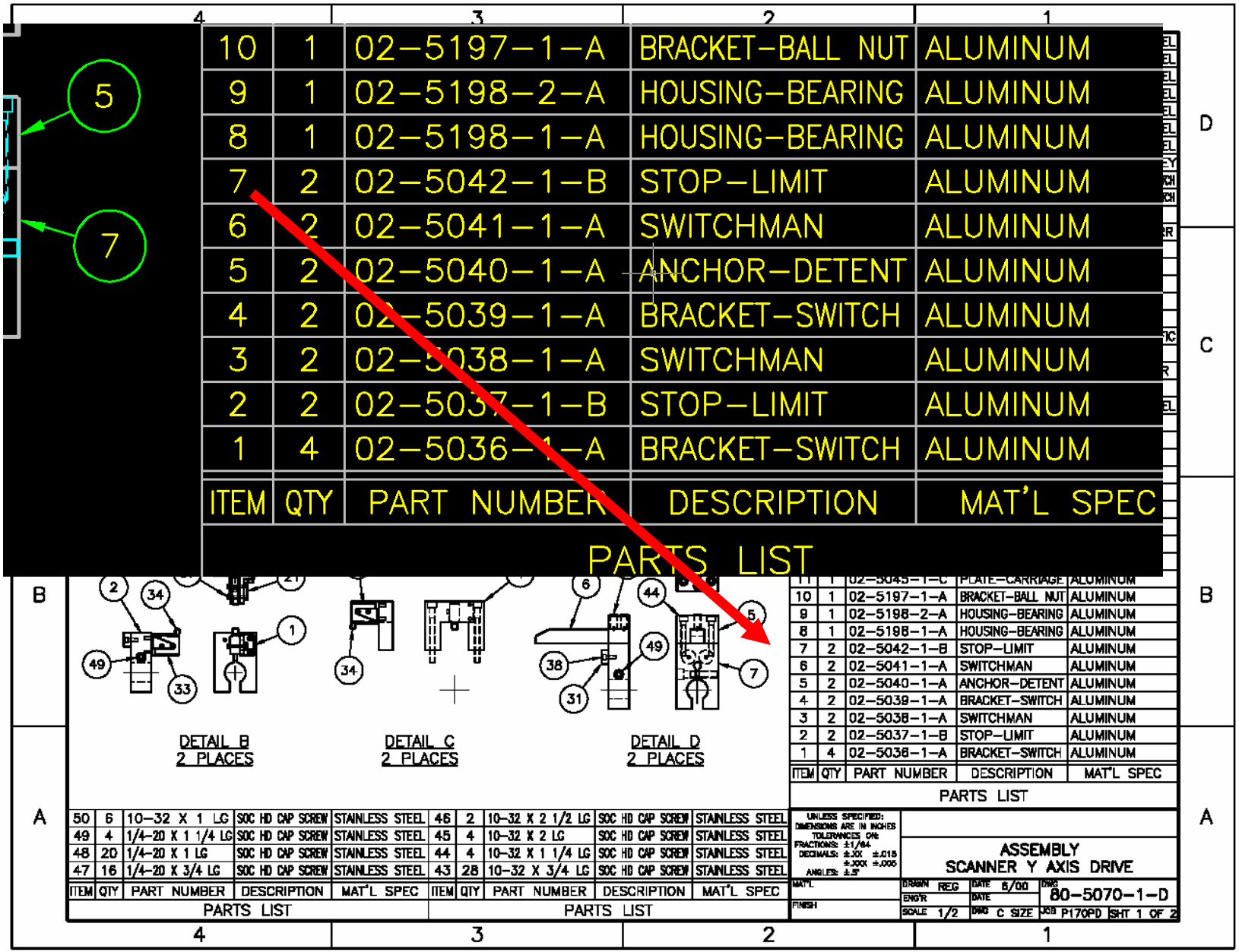


Mechanical Assembly Drawing


REVISIONS
REV | DESCRIPTION | DATE | BY
B | P/N ITEMS 11, 12, 18, & 23 WAS -A. | 7/18/00 | REG
C | REVISED SCREW TO "STAR", GENERAL REVISIONS. | 1/24/01 | REG
D | P/N ITEM 29 WAS CN11-6 | 5/15/01 | REG
DETAIL B 2 PLACES
DETAIL C 2 PLACES
DETAIL D 2 PLACES
PARTS LIST
ASSEMBLY SCANNER Y AXIS DRIVE
80-5070-1-D

Mechanical Assembly Drawing

© Whit Smith 2008



Mechanical Assembly Drawing

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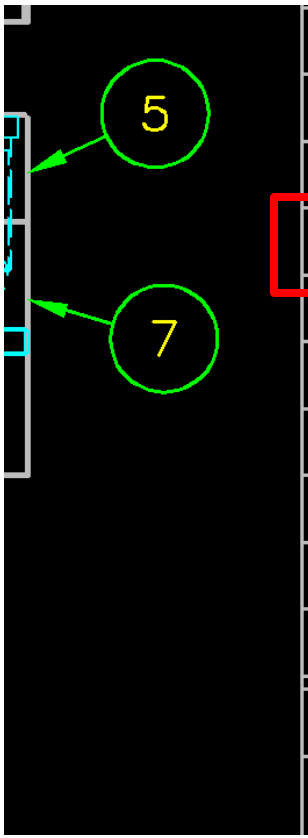
Typical Part Number Block



ITEM	QTY	PART NUMBER	DESCRIPTION	MAT'L SPEC
10	1	02-5197-1-A	BRACKET-BALL NUT	ALUMINUM
9	1	02-5198-2-A	HOUSING-BEARING	ALUMINUM
8	1	02-5198-1-A	HOUSING-BEARING	ALUMINUM
7	2	02-5042-1-B	STOP-LIMIT	ALUMINUM
6	2	02-5041-1-A	SWITCHMAN	ALUMINUM
5	2	02-5040-1-A	ANCHOR-DETENT	ALUMINUM
4	2	02-5039-1-A	BRACKET-SWITCH	ALUMINUM
3	2	02-5038-1-A	SWITCHMAN	ALUMINUM
2	2	02-5037-1-B	STOP-LIMIT	ALUMINUM
1	4	02-5036-1-A	BRACKET-SWITCH	ALUMINUM

PARTS LIST

Points to Associated Mechanical Detail Drawing

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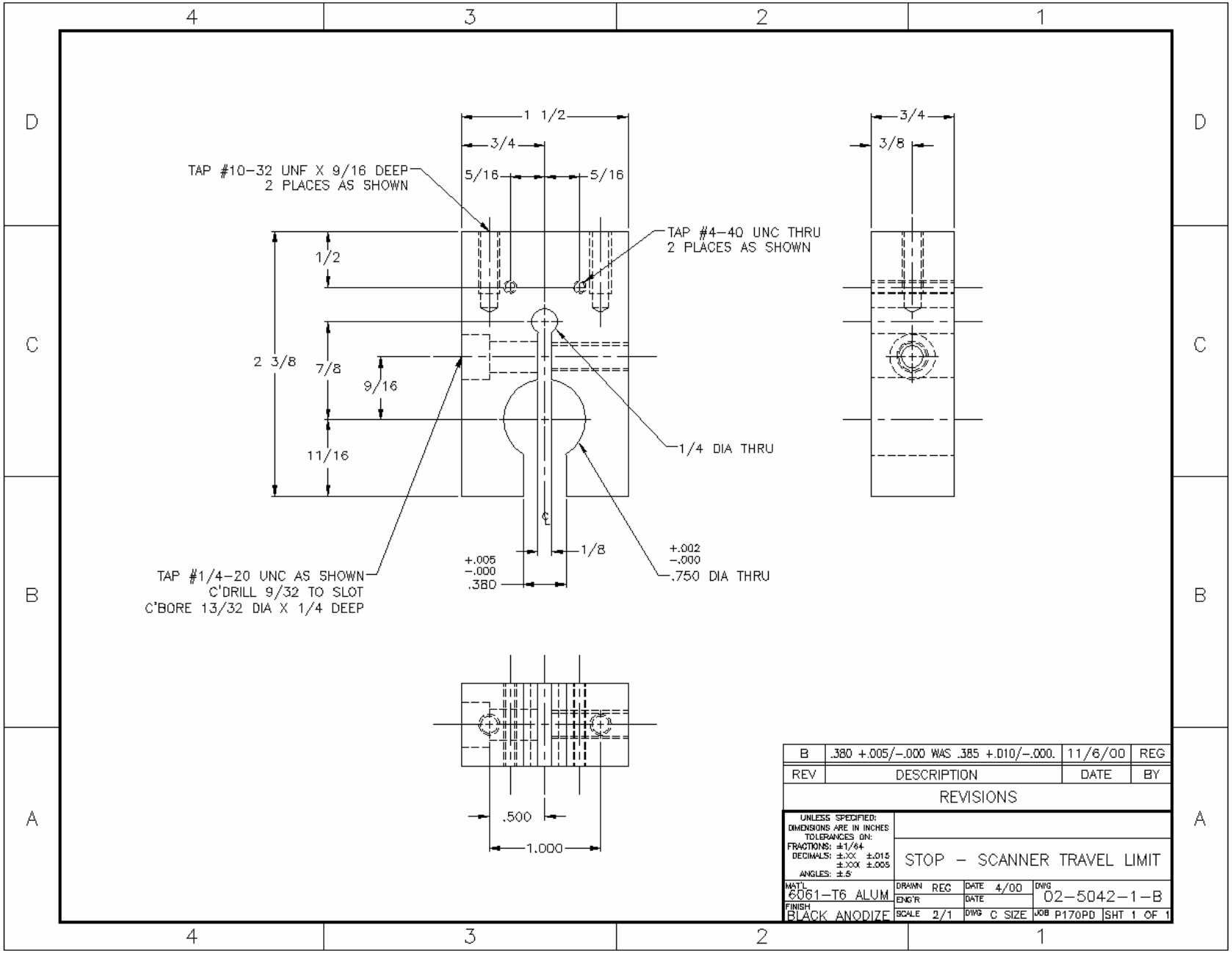

Mechanical Detail Drawing (from Assembly Drawing)

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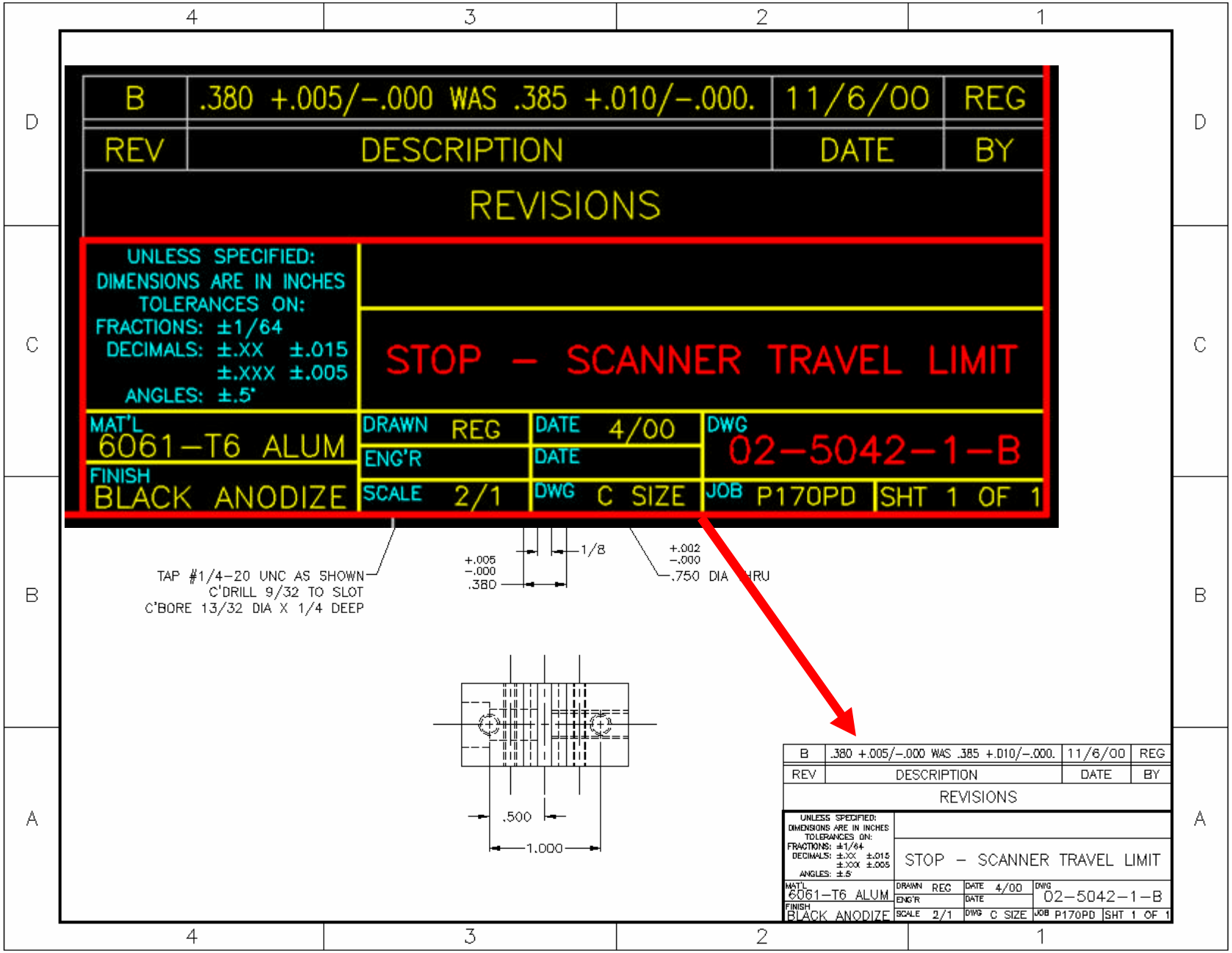

Mechanical Detail Drawing (from Assembly Drawing)

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Interconnection Documentation

- Interconnections can be internal (e.g., between boards in a chassis) and external (e.g., between instruments in a system)
- No standard way to document interconnections
- Standard cables can be identified by part number and name (e.g., CAT6, USB)
- Custom cables have to be described in detail
  - Drawing showing construction details, and/or
  - Table showing pin numbers and wire colors (if needed)
- Wiring (connections with discrete wires) has to be described in detail

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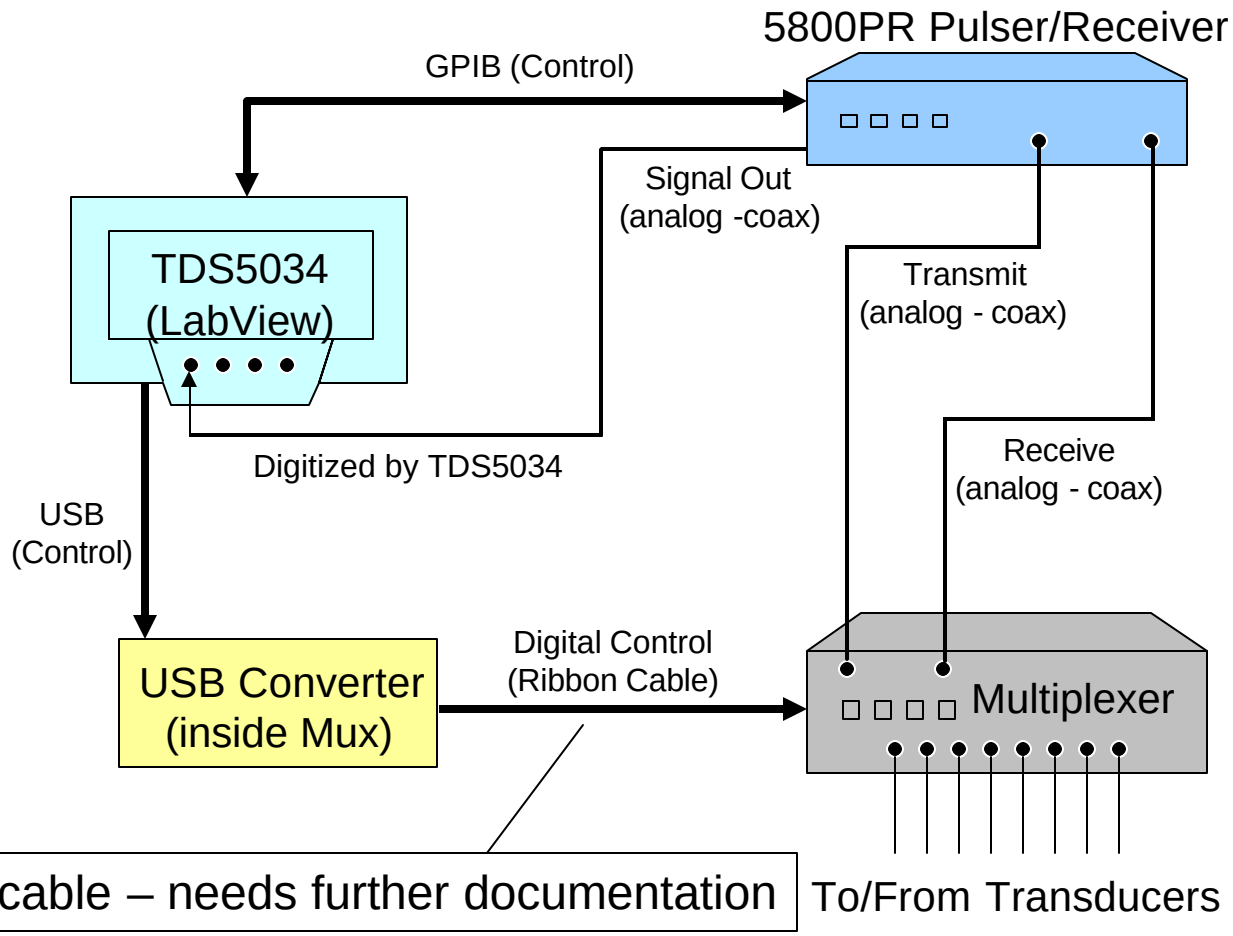
System Block Diagram

Calls Out Interconnections



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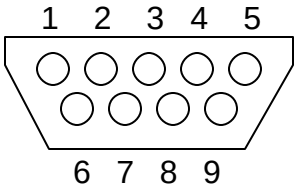
Example – DB9 to Ribbon Cable



DB9 Header

1	2	3	4	5
10	9	8	7	6

Ribbon Header

DB9 Pin	Description	Ribbon Pin
1	Ground	1
2	+5V	2
3	Data0	3
4	Data1	4
5	Data2	5
6	Data3	9
7	Code0	8
8	Code1	7
9	Ground	6
	Not Used	10

Different manufacturers can number pins differently!

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Software Documentation

- Usually a flowchart is useful for helping someone else understand the “flow”
- Also helps the designer figure out how various modules of the software interact
- Software documentation should enable someone else to work on your code
- Well-written and commented source code is absolutely essential

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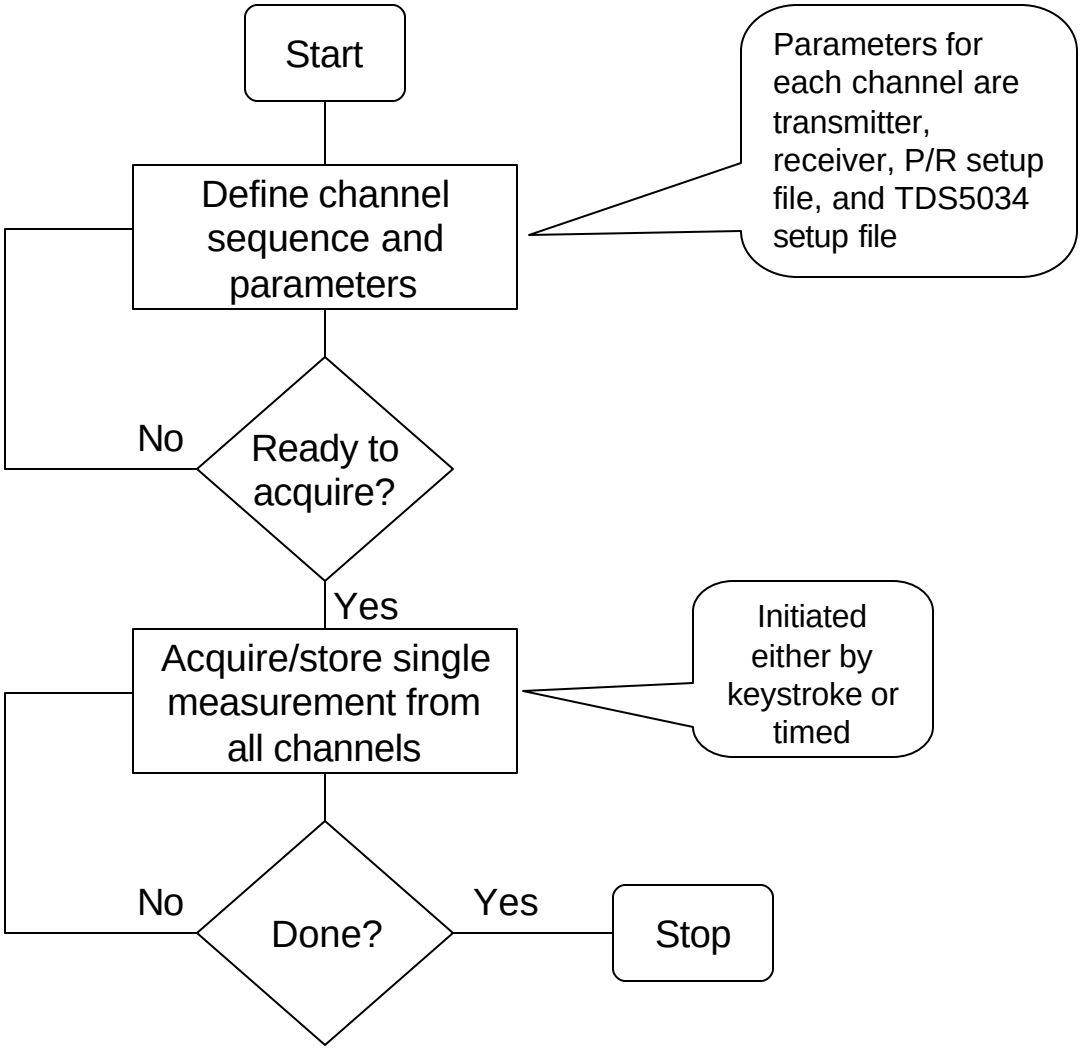
Example “High Level” Flow Chart



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Code Examples

- Are revisions identified and described ?
- Is formatting consistent and clear ?
- Are comments are appropriate (not too few or too many) ?
- Are variable names reasonable (descriptive without being too long) ?

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Maintain Version and Revision Control of Software

Use a version control software product such as:

Microsoft Visual Source Safe

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Typical Software Version Control Features

- Automatically tracks and controls source code changes.
- Provides sharing and linking capabilities for multiple developers.
- Supports parallel development and branching.
- There are overhead costs associated with using version control software.

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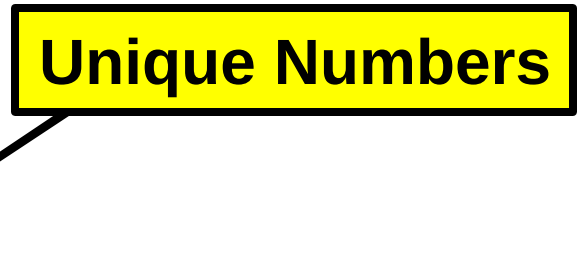
General Revision/Version Control

- Most companies follow strict procedures for version and/or revision control after the product is completed.
- Normally required to comply with dictates of most quality assurance systems.
- ECN (Engineering Change Notice)
- DCN (Design Change Notice)
- Keep an index of ECN/DCN numbers



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Customer Documentation

- User's (Operator's) Manual
  - How does the end user interact with the product?
  - Engineers usually have to write at least some, and often most, of the User's Manual (particularly software engineers)
- Maintenance Manual
  - What does the end user (or the manufacturer) need to know to maintain the product?
  - Engineers usually write this manual
- Many technical writing opportunities for design engineers

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Documenting the Design Process

- Laboratory notebooks (or some paper system of recording your design progress)
  - "Work in progress" sketches, schematics, flow charts, block diagrams, etc.
- Electronic files
  - Software source code
  - Drawings and schematics
- Project correspondence
  - Emails, notes from phone calls, letters, etc.
- Other project documentation

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Project Correspondence

- Any information transmitted to and/or shared with others that relate to the project.
- Customer letters and emails
- Internal memos and emails
- Keep a posted hard copy file with a file index (Table of Contents) to document important project correspondence
- Important to keep organized and up-to-date

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Misc. Project Documentation

- Related research articles
- Vendor information
- Purchasing records
- Meeting notes
- Copies of electronic files

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Preliminary Design Review (PDR)

Upcoming during two weeks of March 3-14

Details specific to your Project Advisor and section

Graded jointly by your Project Advisor and UPCP

Christina Bourgeois will be visiting on Monday to discuss presentation issues.

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